



Indiana Wind Working Group
December 3, 2010

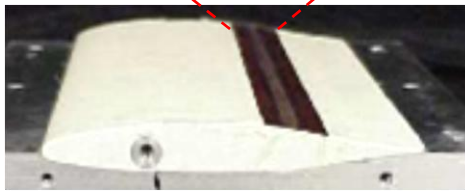
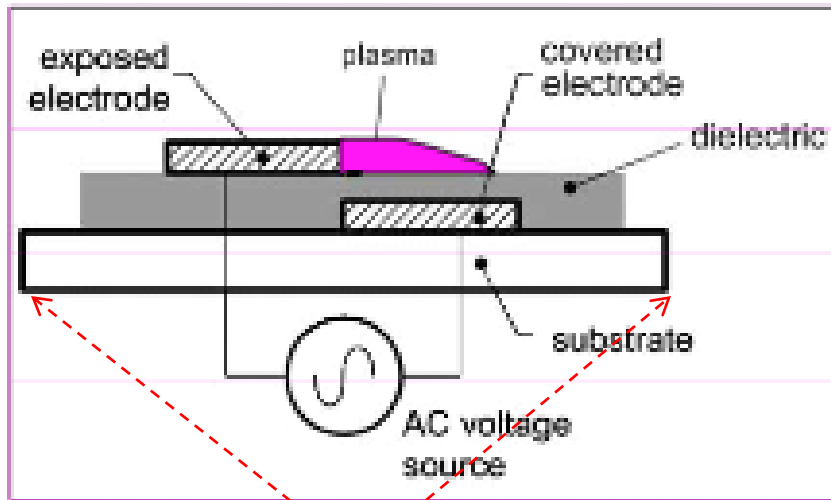
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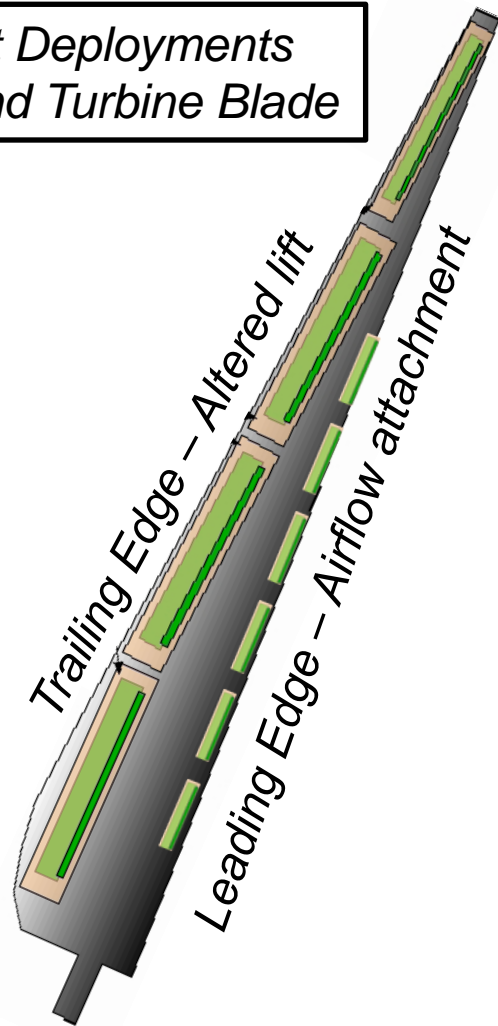
Agenda

- Technology & Market Overview
- How We Got Here
 - Fund Raising
 - Technology Development
 - Technology Licensing
- Where We Are Going

Sorian's Plasma Actuators



*Retrofit Deployments
on a Wind Turbine Blade*



- Electrical current causes air to ionize, creating a plasma field (shown in **purple** above).
- Electrical field manipulates plasma to inject thrust into airflow
- Trailing edge actuators perform identically to a trailing edge flap – enhancing lift with no increase in drag
- Leading edge actuators prevent airflow separation

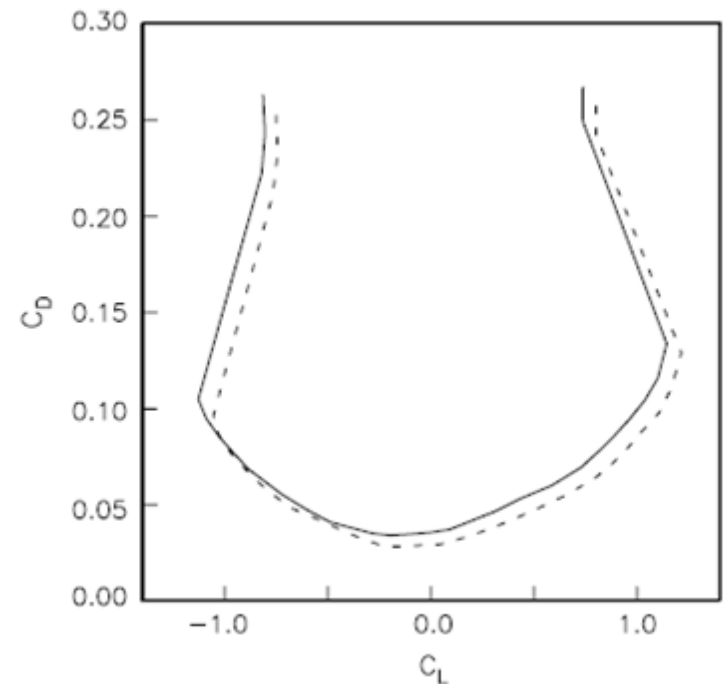
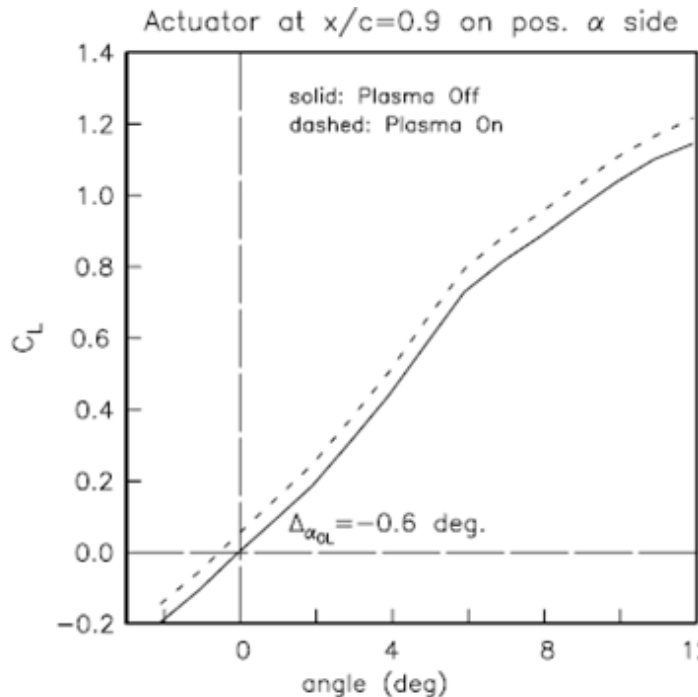
Trailing Edge Actuator Test



NACA 0015

- Trailing Edge Actuator
- Actuator Location = $0.90 x/c$
- 21 m/s
- 7 kV
- Lift Curve and Drag Bucket Shown Below

Source: 'Plasma Flaps and Slats: An Application of Weakly Ionized Plasma Actuators'; Corke et al

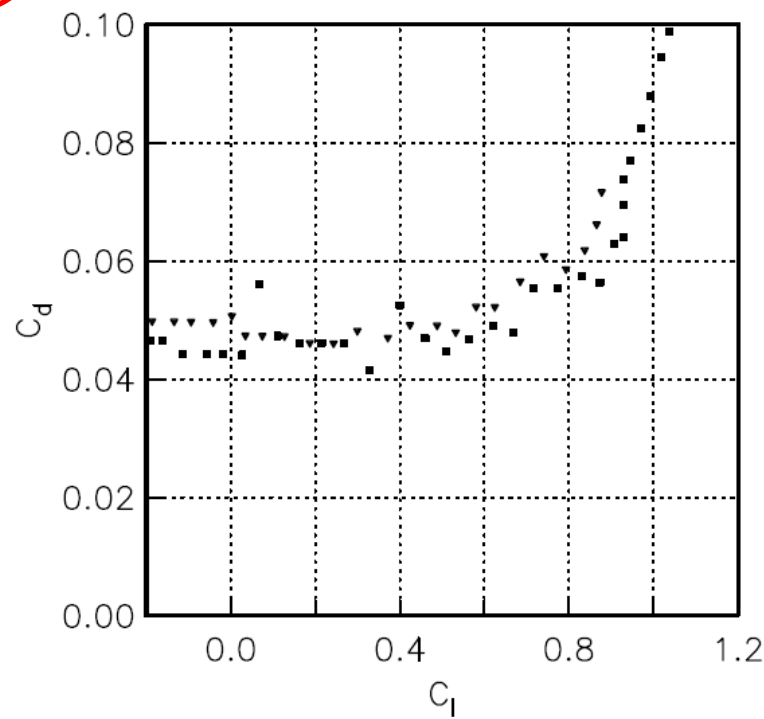
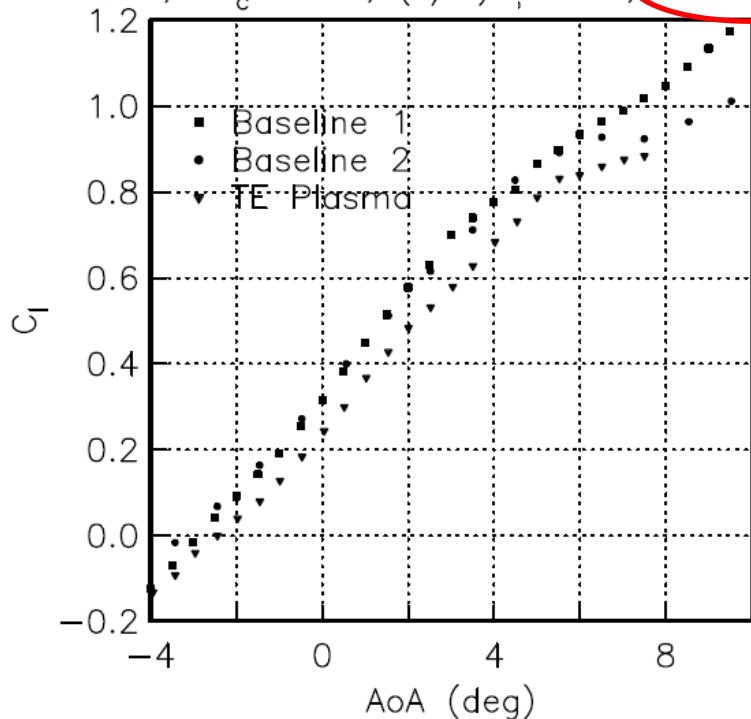


Experimental Results

Decreasing Lift with a Pressure Side Actuator

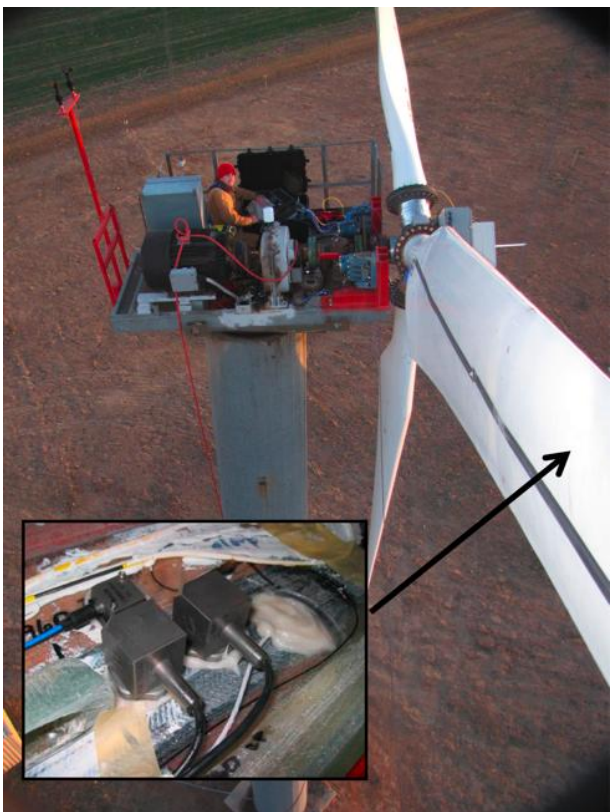


S827, $Re_c=350K$, $(x/C)_t=0.95$, $VAC=15kV$



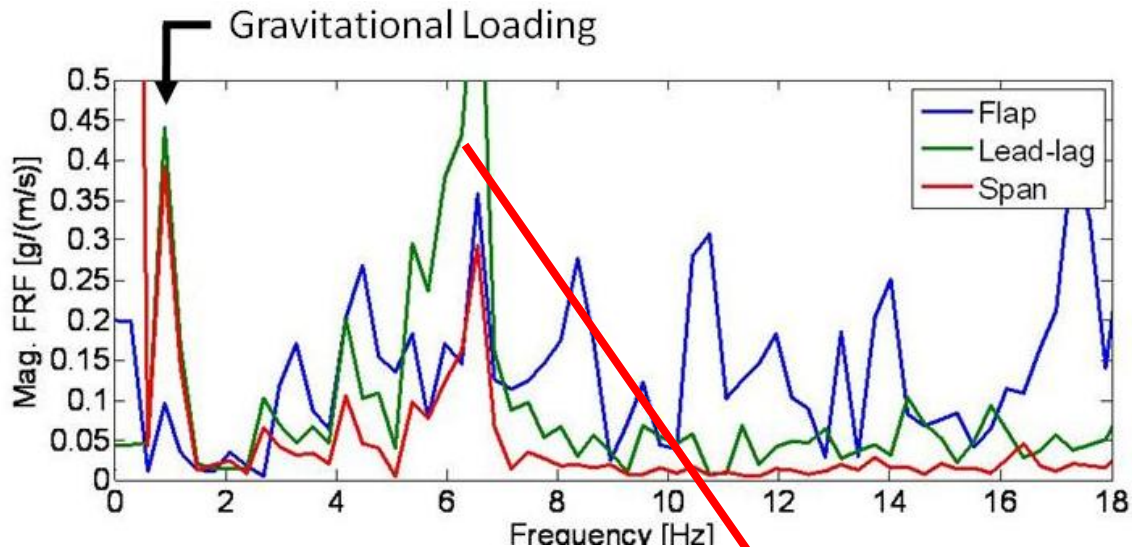
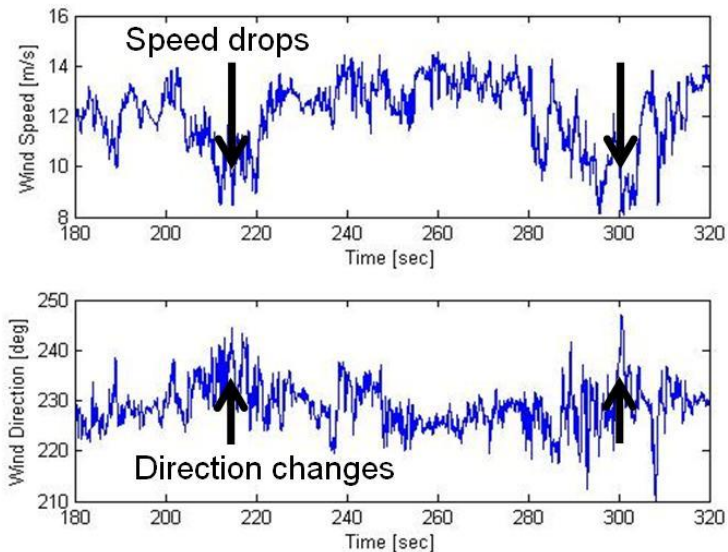
Plasma Actuators Demonstration

Detecting Blade Deflection



- Blade stress detected via accelerometers placed inside each blade
 - Distributed sensors yield high spatial resolution of stress causes
- Separation of blade movement into 3 dimensions
 - Specific identification of stress allows for precision corrective action

Deflection Sensor Data

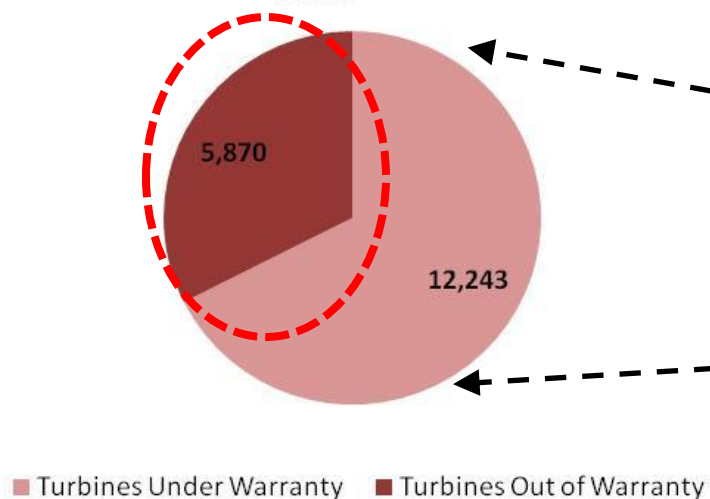


**Blade / gearbox
stress + lost
energy output**

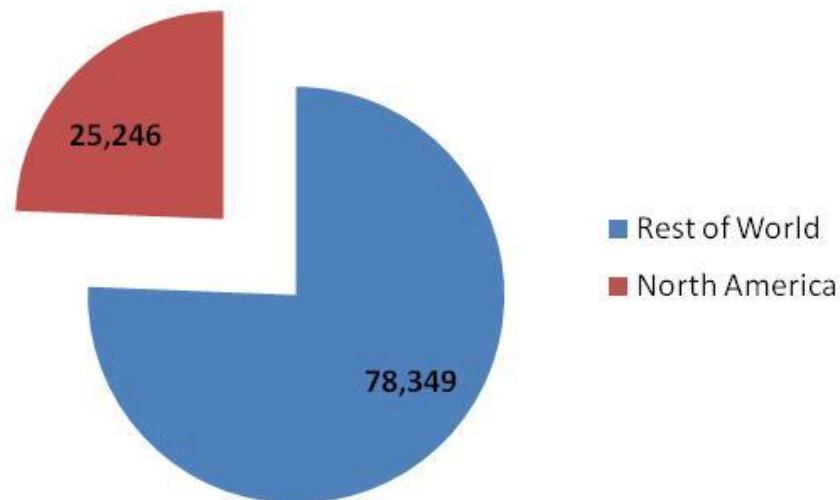


Existing Retrofit Opportunity

North American Turbines > 1MW
2009

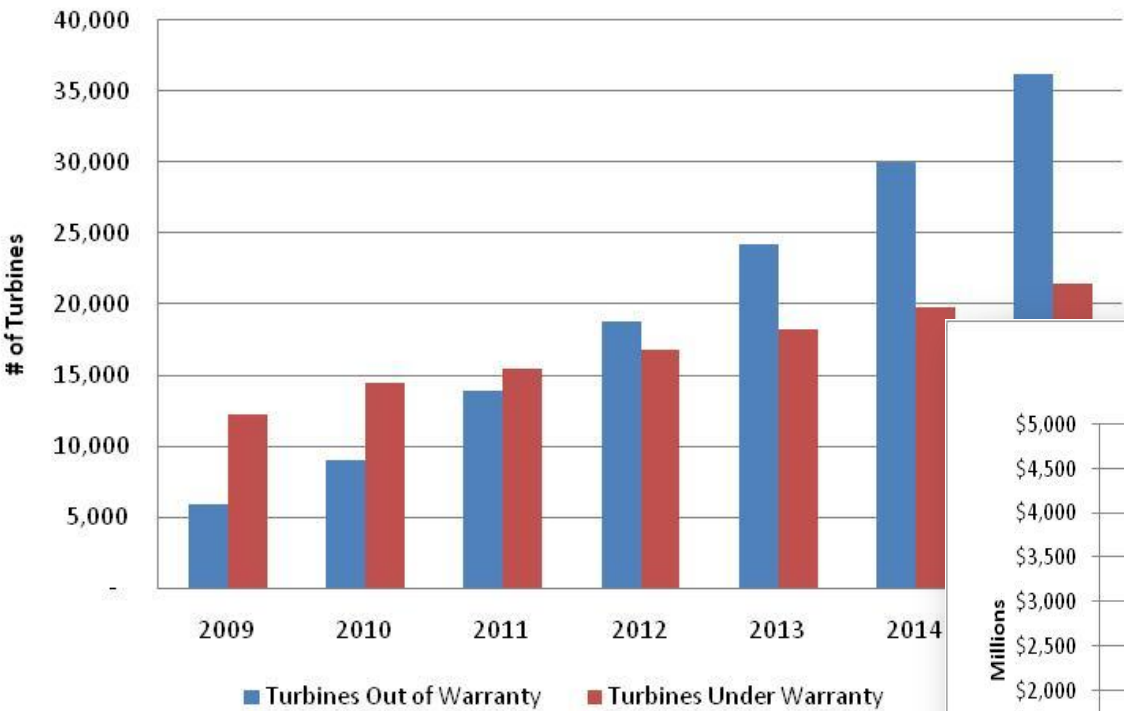


Worldwide Wind Turbine
Installations - 2009

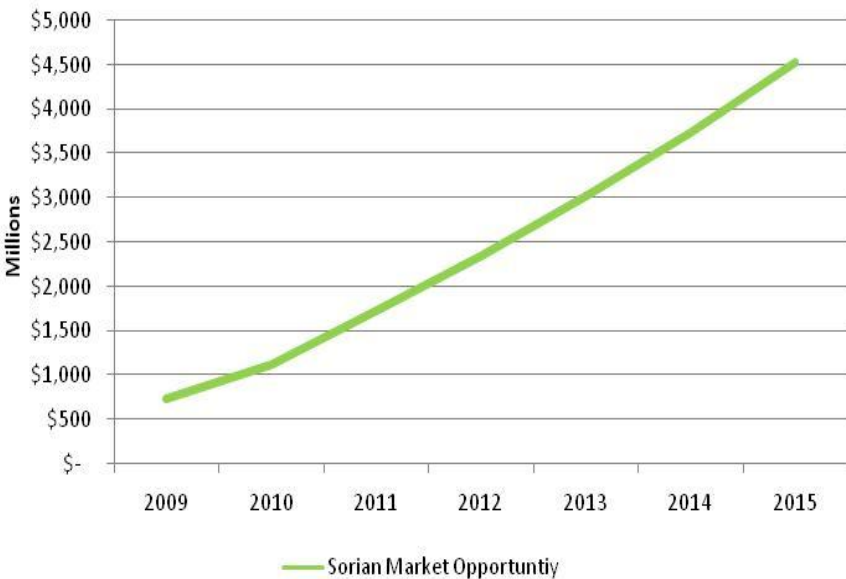


Forward Looking Addressable U.S. Market

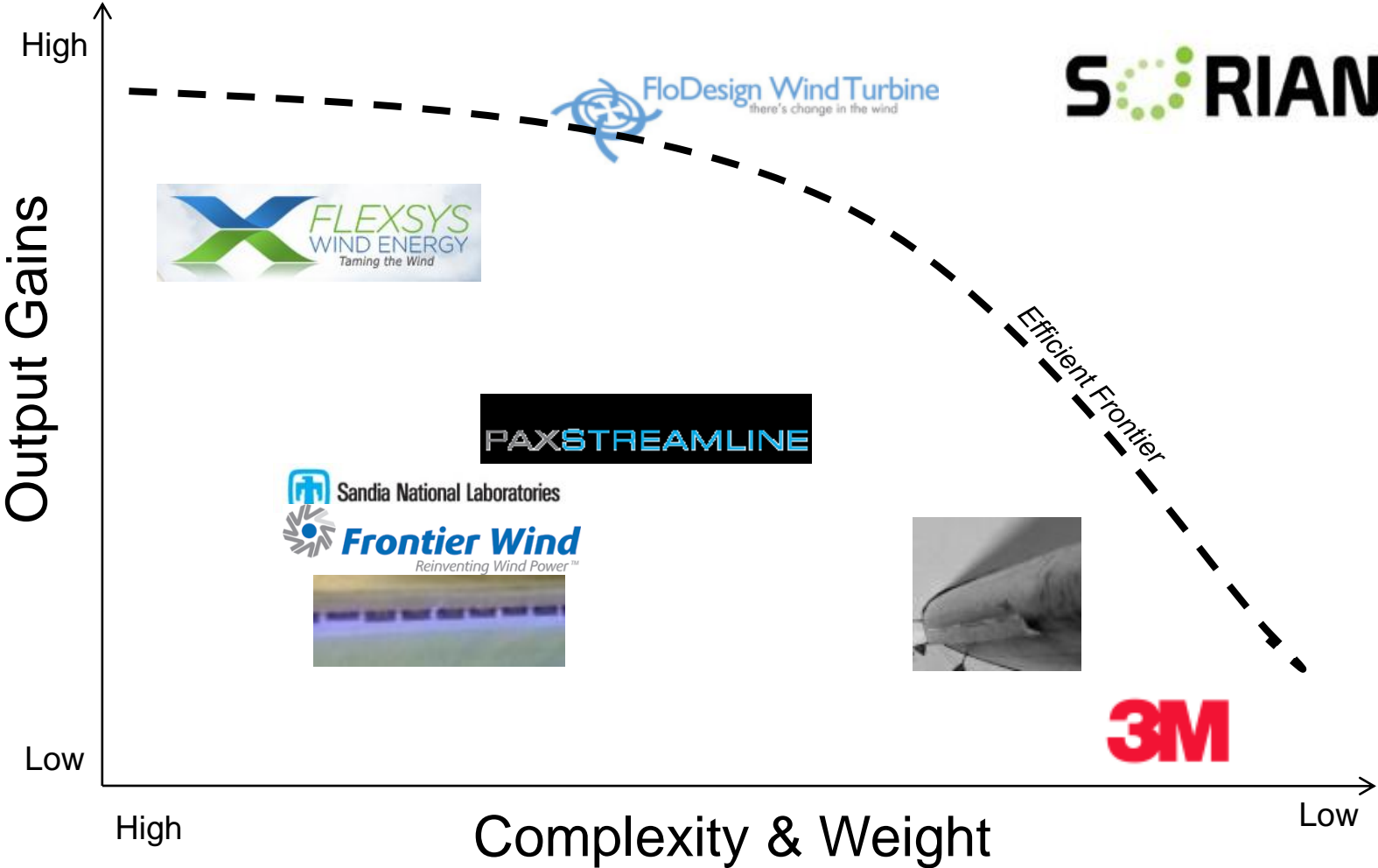
United States Turbine Installations



Sorian U.S. Market Opportuntiy



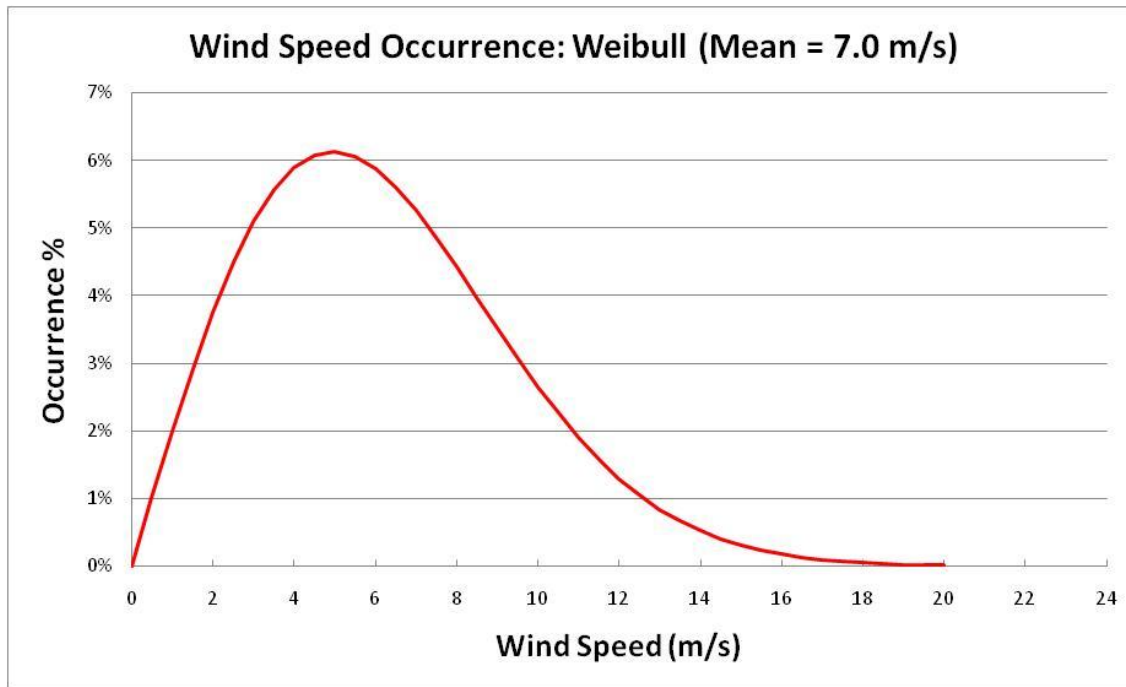
Competing Approaches



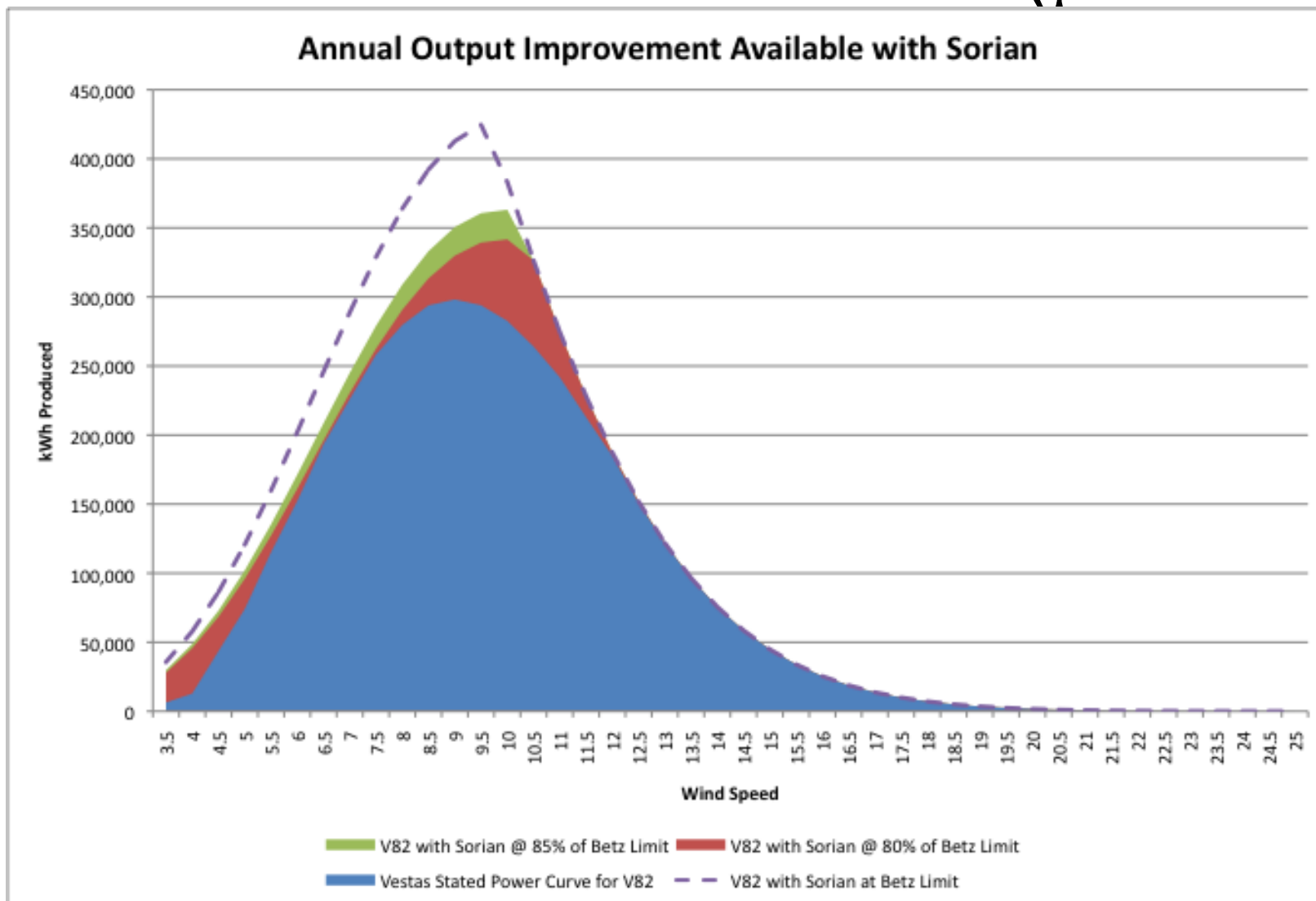
V-82 Performance Model

Weibull distribution applied to determine annual performance improvement.

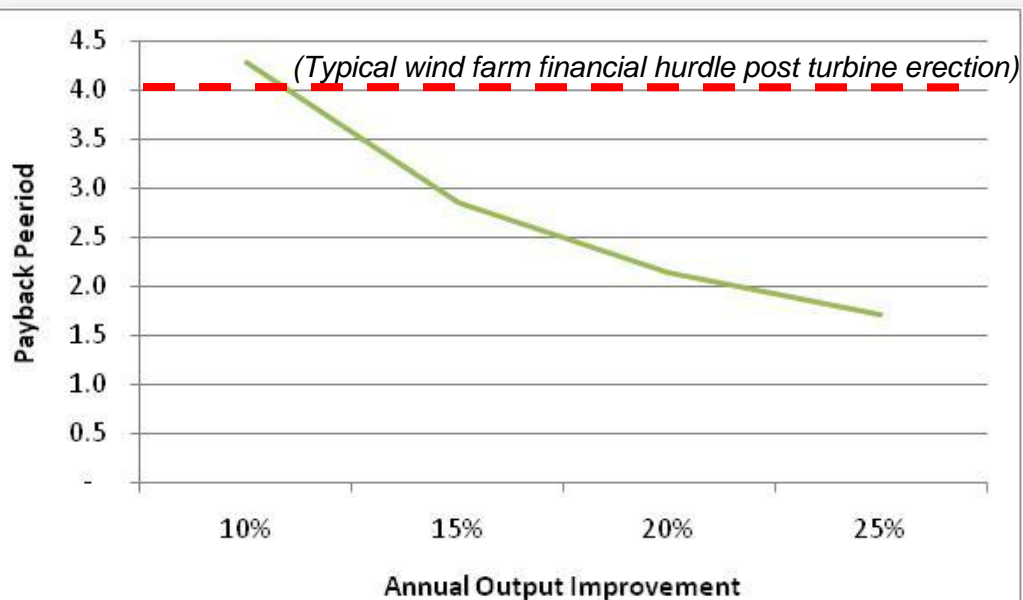
Mean = 7.0 m/s, Shape Factor = 2



V82 Annual Output – Weibull Distribution of Wind ($\mu=7.0$ m/s)



Targeting a 2½ Year Payback



Assumptions:

30 Turbines / Installation

Price / kWh = \$0.06

Baseline Capacity Factor = 37%

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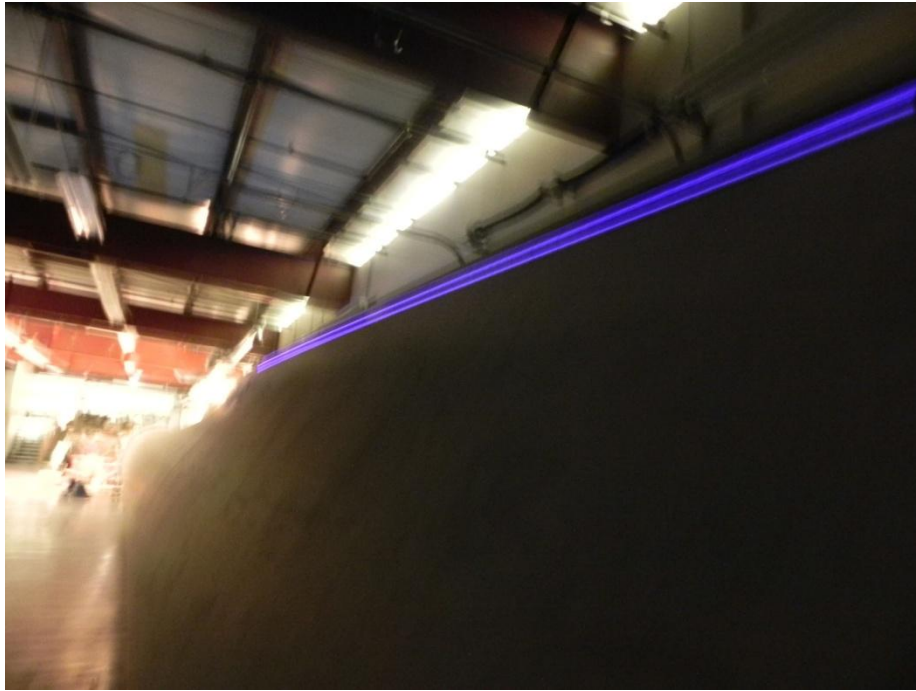
Fund Raising

- Initially Targeted “Angel Investors”
- Thrown into VC Market Earlier than Anticipated
 - Too Early, Lots of Good Feedback
- Raised \$270k to-date. Plus \$200k Grant
- Finalizing Deal with Developer
 - \$1.1M in Funding + Field Test Opportunity
- Currently Raising \$250k to Augment Deal

Technology Development

- Forced to Develop Without OEM Collaboration
 - Expect Collaboration to Start Next Week
- Plasma Actuators of this Scale Have Never Been Made
 - Lots of Customization
 - Difficult to Find Suppliers
- Installation Plans and Procedures
 - Significant Contributions from Leading Wind O&M's and Repair Groups

Technology Development



Ground Test at Dr. Adams' Lab – Purdue University

Technology Licensing

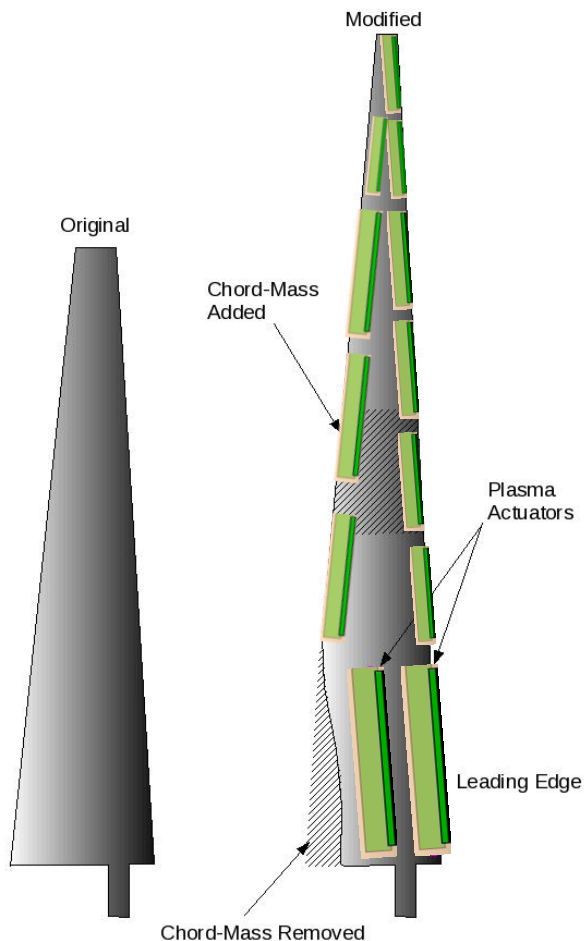
- Plasma Actuators
 - Dr. Thomas Corke: ME & AE - University of Notre Dame
 - Secured Exclusive License to Multiple Fields of Use
- Sensing Technology
 - Dr. Doug Adams: ME - Purdue University
 - Finalizing Exclusive Rights to Multiple Fields of Use

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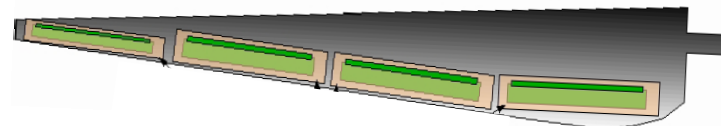
Go to Market Plans

Generation 3



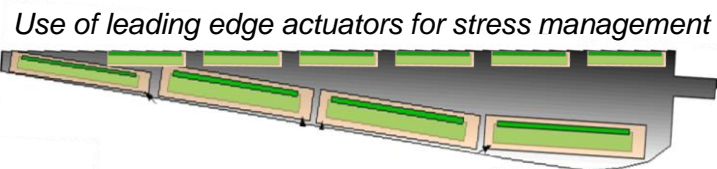
Gen. 1 Retrofit Kit

- 10% - 20% increased power output in Region II



Gen. 2 Retrofit Kit

- Full active control optimized for wind class and turbine model
- Increase in operating range
- Further improved output in Region II



Gen. 3 New Blade Design

- Lower weight blade design using plasma actuators as a 'virtual trailing edge'

Beyond Utility Scale Wind Turbines





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